The Art of Land Navigation

GPS Has Not Made Planning Obsolete

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Conventional land navigation—that is, with map, compass, and terrain association—has never been a strong suit of junior leaders, and it has suffered even more as a result of the global positioning system (GPS) devices now available. The general attitude is that these devices have made such training unnecessary. Another factor in ignoring a detailed land navigation training plan is the difficulty. Few junior leaders can produce a good plan, because they do not have the skills and experience. And few units develop written planning procedures to help them, thereby placing the burden on the commander. Often, even experienced commanders do not have the acquired skills and, even if they do, they need to devote most of their time to the tactical plan. As a result, units are likely to throw a hasty route plan together and hope for the best instead of addressing the task with confidence. It is no wonder that many junior leaders think that simply finding the objective is a sign of mission success.

It is essential that units develop standing operating procedures for land navigation planning. An SOP provides much more than just an orientation aid. It allows the commander to focus on planning the mission; it addresses the effects of terrain, vegetation, and the soldier's load on the rate of movement—providing an appreciation of time and space; and it allows the commander to remain focused on the tactical situation during movement. Reaping these benefits does not require an enormous expenditure of time, labor, or resources, once the system is in place.

The commander delegates the planning task to a platoon leader (hereafter called the chief navigator) during the warning order and gives him general guidance on the route, time constraints, and soldier's load. Using the *Land Navigation Planning Checklist* and the *Land Navigation Worksheet*, the chief navigator develops the detailed plan. For clarity, he makes a *Route Overlay* or sketch and backbriefs the commander when he is finished or has an issue to be

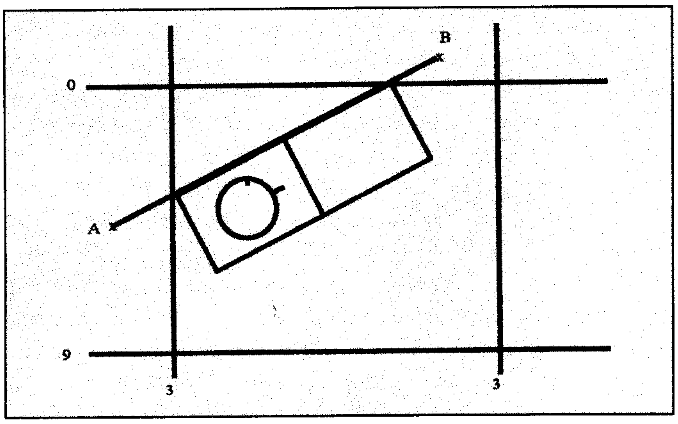


Figure 1. Northern Azimuth

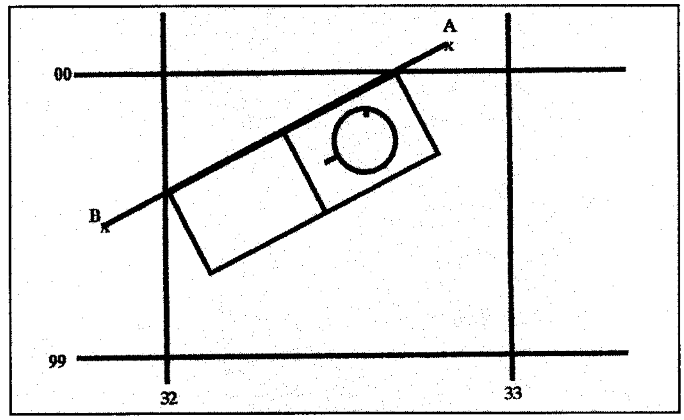


Figure 2. Southern Azimuth

resolved. Once the commander approves the plan, all radiotelephone operators (section, platoon, company, and attachments) copy the land navigation overlay or sketch for their respective leaders. The first sergeant provides quality control during this phase. The chief navigator briefs the plan during the operations order (OPORD), using either a sand table or an enlarged route sketch.

Referring to the map and the *Land Navigation Planning* checklist, the chief navigator develops the route using a systematic approach. Using a straightedge and an alcohol pen or pencil, he draws out the complete route. The route consists of a series of smaller segments called legs. Unless the objective is nearby, the route may consist of numerous legs. The planner uses the worksheet to help him calculate the rate of march of each leg and the total time expended in the movement. This information is then transferred to the route overlay or sketch. (TTP: The planner should have a land navigation kit to assist him in planning: Hand calculator, magnifying glass, pipe cleaners, military protractor or clear ruler, laminated map scale index, and laminated copies of field expedient direction determination techniques.)

A common mistake is to plan a route with only one or two long legs, hoping that one azimuth and straight-line distance will make up for the difficulties in terrain. Unless the terrain is unusually gentle, straight-line routes expend considerable time and exhaust soldiers. Once committed to this inflexible plan, leaders are reluctant to deviate from the azimuth, even if the terrain or tactical situation may warrant it, for fear that deviations will lead to inaccuracies and increase the odds of getting lost. This forces the unit to move over compartmentalized terrain and numerous hills, wade through swamps and streams, and claw through scrub brush and wait-a-minute vines just to stay on course. The greatest fear then is how enemy contact will disrupt the land navigation effort instead of how the unit will react to it. In effect, the commander is captive to an impractical and inflexible method of navigation.

Collecting features—such as a stream, road, woodline, or lake—can be used to mark the distance of each leg between two distinct and recognizable start and end points (also called waypoints). When traversing featureless terrain, legs are demarcated by time, rate, and distance. Each leg portrays the magnetic azimuth (not the grid azimuth), the distance, and the estimated consumption of time. Since pace-count inaccuracies increase over long distances, the planner attempts to limit legs to 1,000 meters or less, particularly in rough terrain. A new leg doesn't necessarily mean a new azimuth. It is simply a way of verifying the unit's location and starting a new pace count. The start and end points are signals for the unit to pause and verify its progress along the route. Most important, this progress is disseminated throughout the unit for everyone to know. That way, if elements should be separated from the company, the new leader will have an idea of his present location and proceed from there.

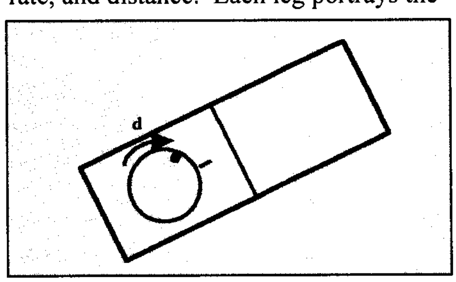


Figure 3. Eastern Declination

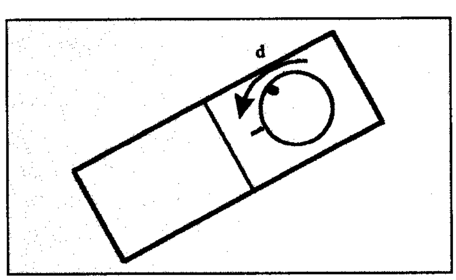


Figure 4. Western Declination

Terrain *handrails* also help develop the route. A handrail is a terrain feature parallel to the direction of movement, such as a ridge, stream, road, railroad embankment, power lines, or woodline. As the name implies, a handrail guides the unit along its route with assurance.

If the *collecting* feature at the end of a leg is a distinct point, such as a road intersection, the navigator should deliberately offset 10 degrees to the left or right of the point. Each degree of offset results in a deviation of 18 meters to the left or right of a point at 1,000 meters. Having deliberately offset from the point, the navigator can move straight to the point (left or right) at the end of the leg to maintain course accuracy. Since intersections are likely to draw the enemy's attention, it is better to send a reconnaissance team to verify the point's location and tell the navigator how far the unit is from it.

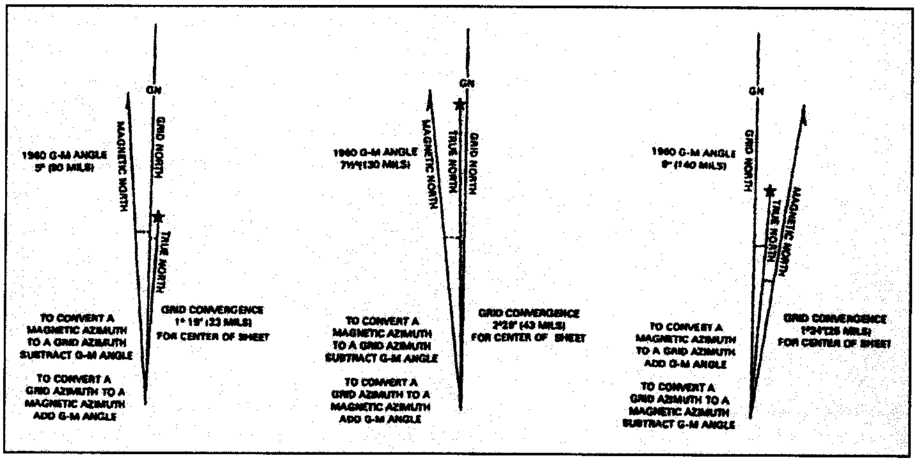


Figure 5

Another navigational aid is a *catching* feature—a clearly identified terrain feature that tells the unit it has moved too far along a leg. The selection of terrain features to delineate each leg is particularly important for night navigation. The navigator cannot rely on the recognition of distant terrain features (ridge lines, mountains, hills, woods) since he has less depth perception at night, causing these features to blend together. A patch of woods could look like a hill or a ridgeline. Trees that line a stream can completely disguise its existence in the dark. In this sense, triangulation is rarely possible at night. Verification requires that someone physically check out the feature.

Determining azimuth between two points. To determine the azimuth between two points on a map, the planner can use either a protractor or a lensatic (military) compass. The protractor is excellent in a classroom, but tends to be a little unwieldy in the field. It also provides only the grid azimuth, forcing the planner to use scratch paper to convert to the magnetic azimuth, and the planner is hard-pressed if he loses it. In this regard, learning to use the compass is not only easier for use in the field but also faster for converting from grid to magnetic azimuth. The method with a compass is shown in Figures 1 and 2:

- Place a ruler, or draw a line, between the two points directly on the map.
- Place the graduated straight edge of the compass parallel to the line, with the front of the compass pointing in the direction of travel.
- Determine the grid azimuth. Rotate the bezel ring so that the short luminous line is parallel to the north-south grid lines on the map and is pointing toward grid north. (Each click on the bezel ring represents three degrees. This is useful to know when changing azimuths at night.) Rotate the compass until the luminous line is aligned with the north-seeking arrow. The reading on the compass (fixed black index line) is the grid azimuth. (For civilian compasses, align the bezel ring interior lines parallel to the north-south grid lines of the map with the arrow marker—not the needle—pointing toward grid north.)
- Determine the magnetic azimuth, also called "accounting for declination" (Figure 5). Somewhere on each map is a declination symbol, normally displaying three arrows. The line with the star symbol at its tip represents true north. We are concerned with only two of these. The line with the letters "GN" at the tip is grid north, and is parallel to the north-south grid lines. Next, locate the magnetic north line; it is a solid arrow cut in half with the letter "M" at the tip. This line is either left (west) of or right (east) of the grid north line. The angle between the grid and magnetic lines is the declination. Keeping the compass on the line of travel, rotate the bezel ring toward magnetic north (left is counterclockwise, right is clockwise) the number of degrees between the grid north and the magnetic north lines. Align the short luminous line with the north-seeking arrow and read the azimuth from the fixed black index line; this reading is the magnetic azimuth.
- For precise declination calculations, the planner can make a declination diagram for conversion calculations. The first step is to draw the grid north and magnetic lines on a scratch pad, referring to the declination diagram on the map. Next, draw a reference line to the right of the grid north line and perpendicular to it. Now, draw an arc between the grid and magnetic north lines and insert the number of degrees separating the two (as shown on the map)—this is the declination angle. Continue by drawing an arc between the grid and reference lines and inserting the grid azimuth—this is the grid azimuth angle. The angle between the magnetic and reference lines is the magnetic azimuth. To obtain this, add or subtract the declination angle from the grid azimuth angle. For example, an eastern declination (one with the magnetic north line to the right of the grid north line), the magnetic azimuth is the grid azimuth angle, minus the declination angle. For a western declination, the magnetic azimuth is the grid azimuth angle *plus* the declination angle. Naturally, this method is used to convert from magnetic to grid azimuth as well.

Calculating time and distance. Four factors influence the rate of movement of dismounted infantry: climatic conditions (weather, percent of illumination), vegetation, terrain, and the soldier's load. Accurate assessments of the effects of these factors are a product of both experience and experimentation.

Climatic conditions are very difficult to quantify, and they vary so much that their effect on the rate of march will depend on both the area of operations and the condition of the soldiers conducting operations. It may be enough to understand that in deep snow, thick mud, or heavy rain that results in slick ground, the company will get there when it gets there. The amount of illumination also slows the rate of advance, but with enough night training—and realistic expectations of the leaders—soldiers can maintain a rate that is in line with the night movement-planning

Like weather and climate, determining the effect of vegetation on the rate of movement is a virtual unknown until a unit moves through similar vegetation. Although some data is available regarding the effect of vegetation on the rate of movement, the unit will probably need to develop its own empirical data. Generally, a unit should avoid heavy vegetation. Although this may increase the total distance traveled, it may still result in a faster rate of movement. Night movement in heavy forests and jungle is so difficult that it is often better to wait until daylight.

The effect of the terrain is the most prevalent and crucial factor in land navigation. Fortunately, civilian orienteering has at least provided numerous methods of calculating the effect changes in elevation have on route planning, a major consideration.

- Horizontal Distance—For flat terrain, simply measure the distance along a leg using a protractor or laminated map scale. Add 20 percent to the straight-line distance to account for slight course deviations and minor elevation changes. To determine distances along a road, trail, or stream, use a pipe cleaner with annotated map scale tick marks. Trim the pipe cleaner to conform to the road, and put a tick mark on the map to indicate the distance covered. To account for error, add 10 percent to the total distance measured. Use a pipe cleaner for movements along the same contour interval (moving around hills or along ridges, for example).
- Elevation Conversion—When the route is over elevated terrain, the planner must account for the effect the slope will have on the rate of march as follows:

  - Verify the contour interval from the map information. Using a magnifying glass, count the number of contour lines that the leg crosses. Subtract the lowest contour from the highest contour level to get the change in elevation, or vertical distance.
  - Using the general rule of 10:1, convert the change in elevation to the horizontal equivalent. For purposes of determining the rate of march, this means that each meter of rise or fall is equal to 10 meters of flat distance. This figure is called the *elevation conversion.* (Note 1: Because the 10:1 rule already accounts for course deviations, the planner does not add the 20 percent deviation factor. Note 2: This is not the actual distance the unit must traverse for pace count purposes. For the pace count, the planner should use the Pythagorean Theorem ($a^2 + b^2 = c^2$) where a is the horizontal distance, b is the vertical distance, and c is the slope distance.)

- Combined Distance—The *elevation conversion* is added to the *horizontal distance* to get the *combined distance.* For example, the horizontal distance between the bottom and the top of a hill is 1,000 meters + 2,000 meters = 3,000 meters.
- Time Expenditure—The general

LAND NAVIGATION PLANNING CHECKLIST

1. Receive initial guidance from commander during warning order regarding the route:

a. General primary and alternate routes with cover and concealment.

b. Times for SP, occupation of ORP, and time of attack.

c. Soldier's load—maximum weight.

2. Plan tentative primary and alternate routes using map recon:

a. Designate the legs of the route.

• The start- and endpoints (waypoints) of each leg are demarcated by collecting features (clearly defined and recognizable terrain features as an aid to navigation).

• Distinct changes in elevation (slopes) are also designated as legs.

• Navigational handrails (terrain features that run parallel to the leg) such as streams, ridges, or roads, are used as a navigational aid whenever possible.

• When handrails are not available, plot the leg endpoint to a collecting feature, such as a road or stream intersection, deliberately aiming off (about 10 degrees) to the left or right of the point.

b. Determine the magnetic azimuth of each leg:

• Using a protractor or a compass directly on the map, determine grid azimuth.

• Convert grid azimuth to magnetic azimuth on each leg.

c. Determine the distance in meters for each leg:

• Using the scale on the protractor or the map, measure the horizontal distance of each leg. Add 20% to distance measured to account for minor deviations and changes in elevation.

• For road or trail movement, use pipe cleaner to measure distance traveled. Add 10% to distance to account for error.

• Determine the change in elevation by subtracting the lowest contour line from the highest contour line of each leg.

• Using the 10:1 rule, convert change in elevation into horizontal distance equivalent for time calculation (for example, 100 meters change in elevation equals 1 kilometer of level ground), called Elevation Conversion. Do not add 20% to the horizontal distance.

d. Estimate travel time per leg:

• Rate of March

Rate of March	Day (kph)	Night (kph)
Road	4.0	3.2
Cross Country	2.4	1.6
Trail	3.0	2.2
Deciduous Forest	0.5	
Tropical Rain Forest	1.0	
Secondary Jungle	0.1-0.5	
Tall Grass	0.5	
Swamps	0.1-0.3	
Rice Paddies (Wet)	0.8	
Rice Paddies (Dry)	2.0	
Plantations	2.0	

• Time Expenditure = (Horizontal + Elevation Conversion Distances) ÷ Rate of March.

• Soldier's Load Factor: Subtract 2km for every 6 hours of movement for each 10 lbs load over 40 lbs (e.g., a 70-lb load results in a loss of 6 kms over 6 hours marched from the total planning distance).

e. Calculate Closure Time.

• Calculate length of column. (Lgthcolm) = number of soldiers x table factor + total column gaps between units. Table Factor: Single column (5m/man) = 5.4; (2m/man) = 2.4.

• Closure Time = length of column ÷ rate of march.

f. Identify a catching feature (clearly defined and recognizable terrain feature) to alert the unit that it has gone too far on a leg (use if no catching feature exists for a leg).

g. Identify an attack point within 1 km of the ORP on or near recognizable terrain feature to serve as linkup point for company recon or as a point for precision navigation to ORP.

3. Backbrief commander:

a. Provide him with the Route Worksheet and Route Overlay.

b. Upon approval of the route, add rally points (RPs).

c. Coordinate with FIST for TRPs along the route to include RPs.

4. Prepare route briefing for OPORD:

a. Company, platoon, and section RTOs report to platoon CP to copy route overlay.

b. Platoon RTO (and assistants) prepare route sand table if required.

planning rate of march on a road is four kilometers per hour (kph) during the day and 3.2 kph at night. For flat, open terrain it is 2.4 kph during the day and 1.6 at night. The rate of march factors in a 10-minute break for every hour on the march. Even if such rest halts are not planned, the planner should allow this time to account for unscheduled halts (navigation check, security halt, etc.). Using the time-rate formula, calculate *time* = *combined distance* divided by *rate of march*. Continuing with the above example, the night cross-country time expenditure over a distance of 1,000 meters with a rise of 200 meters is 3 km divided by 1.6 kph = 1.9 hours. The land navigation planner can use this calculation to determine whether it is faster to negotiate elevated terrain or bypass it. He must bear in mind that the physical burden on soldiers favors bypassing such obstacles whenever possible.

A factor often overlooked is the amount of time it takes for the unit to completely close on the objective rally point (ORP). Most movements are conducted in one-column formation, especially at night. The commander must tell the planner how many soldiers will be involved in the movement so he can calculate the length of the column. The table factor accounts for the interval between soldiers. The total of column gaps accounts for the gaps (usually 50 meters at night) between the advance guard and between the distinct company elements. Usually, because of the darkness and the difficulty of the terrain, the only gap will be between the advance guard and the main body.

- Soldier's load—As a final step, the planner calculates the effect of the soldier's load on the rate of march. The soldier's load should never exceed 70 pounds, with 35 pounds being the ideal. Obviously, the lighter the load, the easier it is to maintain a predictable rate of march. For every 10 pounds over a 40-pound load, the planner subtracts two kilometers from the total distance covered in six hours. The planner can show this on the sketch by drawing a blue phase line at the six-hour point and a red line at the appropriate subtracted distance to show the effect the load will have on the movement. This precludes the need for yet another calculation in the plan.

Time Schedule. Starting with the line of departure (LD) time, each leg's time expenditure is applied to real time. In this manner the commander can track the progress, alerting the navigator early if the unit falls behind schedule and giving him time to make adjustments. Lastly, the schedule accounts for ORP occupation time. The unit should occupy the ORP at least two hours prior to the attack time to account for the leader's recon completion of the plan, and the movement into final positions. If the schedule reveals that the unit cannot complete its movement on schedule, the chief navigator backbriefs the commander immediately and offers recommendations that will get the unit there on time.

Route Overlay. Deciding whether to use an overlay or a sketch depends on the scale of the map and the distance to be covered. Generally, map overlays require very small writing and tend to be too busy. A sketch more easily shows all the necessary information, is easier to brief, and is much easier to understand. A sketch should have, as a minimum, grid lines and grid coordinates beside each waypoint. The sketch portrays each leg with the magnetic azimuth, actual distance, and time expenditure. It also depicts the terrain delimitations of each leg, rails, and limit of advances. The land navigation planner's platoon sergeant supervises the

LAND NAVIGATION WORKSHEET

Leg #	CP/Grid	CP Description	Azimuth	Horizontal Distance (+20%)*	Change in Elevation	Elevation Conversion (10:1)	Combined Distance HD+EC	Time Expenditure T=CD/Rate	Time Schedule SP: 1900 hrs	Remarks
1	m/123456	LD	47°	960m	—	—	960m	36 min	1936 hrs	Rate = 1.6 kph
2	k/123456	Stream	47°	360m	—	—	360m	14 min	1950 hrs	
3	a/123456	Ridge bottom	88°	1320m	—	—	1320m	50 min	2030 hrs	
4	s/123456	Stream	354°	450m	+40m	400m	850m	32 min	2102 hrs	Contour interval = 20m
5	g/123456	Ridge bottom	354°	400m	+100m	1000m	1400m	53 min	2155 hrs	
6	b/123456	Trail	354°	350m	–80m	800m	1150m	43 min	2238 hrs	
7	z/123456	Ridge bottom	354°	600m	–20m	200m	800m	30 min	2308 hrs	
8	f/123456	Highway 1	336°	960m	—	—	960m	30 min	2338 hrs	
9	c/123456	Hill	306°	1500m	—	—	1500m	56 min	0034 hrs	
10	e/123456	River bend	260°	420m	—	—	420m	16 min	0050 hrs	Linkup point
	ORP								0115 hrs	Closure Time: 25 min.
									0500	Attack
TOTAL				7320M				5.6 hrs		

*Note: Do not add 20% course deviation for legs traversing elevated terrain; the 10:1 rule already factors it in.
Add 10% to distance measured on a road movement to account for measurement error of pipe cleaner method.

RTO's reproduction of the master overlay in time for the OPORD.

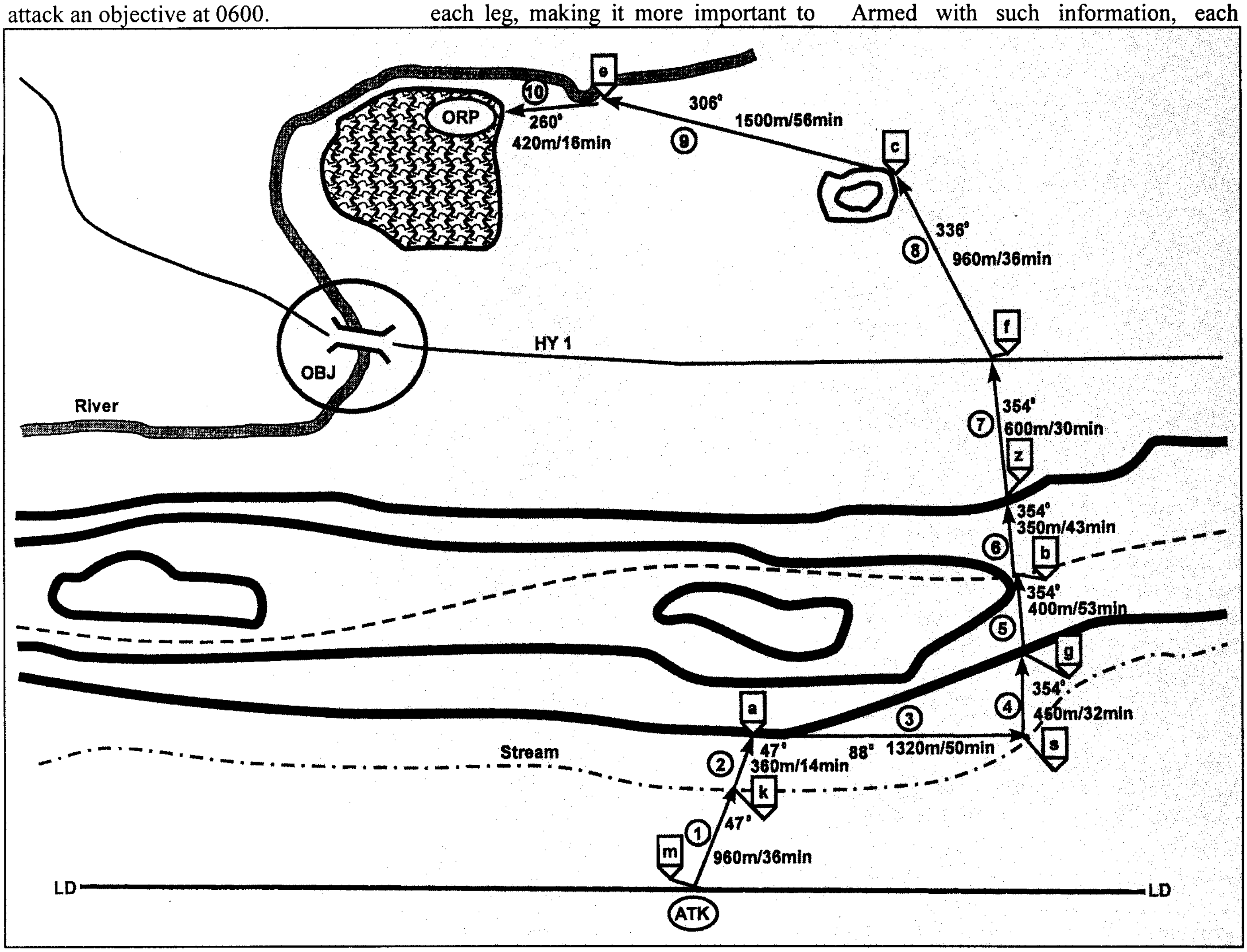
End Result of the Plan. Besides reducing the probability of getting lost, the land navigation plan provides the commander with the estimated duration of movement, which gives him an excellent insight into time and space considerations. With this information, the commander has an idea of how much time he has for the leaders' recon or mission contingencies. It also gives junior leaders an appreciation of such matters, which will help them when *they* become staff officers or NCOs. The company commander provides this feedback to the battalion commander, the XO, and the S-3 immediately, because it affects the synchronization of the plan. Armed with such figures, the company commander can assist the S-3 in planning for the company to cross the LD at 2100 hours, cover the necessary distance in mountainous terrain, and attack an objective at 0600.

Junior leaders should regard these planning figures as a starting point. As part of the after-action review process, the commander tasks the land navigation planners with tracking and recording the actual expenditure of time for each leg. This will eventually yield a planning data base for march rates over various types of terrain, in differing conditions, and under different loads. Tedious and time-consuming? Yes. But it provides the company with precise figures for estimating the amount of time required to reach an objective. Once the database is complete, the hard part is over—except for the walking and climbing.

The same discipline applies to mechanized or motorized movement. The disadvantage in a mechanized movement is that tracked and wheeled vehicles normally cannot move along a straight azimuth. They must go around obstacles from point A to point B of each leg, making it more important to use pipe cleaners to determine distances on the map. In comparison with other mechanical measuring devices, the pipe cleaner is probably more accurate and easier to manipulate. The good news is that elevations and vehicle loads are hardly limiting factors, but weather affects mechanized and motorized movements more so than dismounted movements. Thus, the mechanized unit also needs to maintain a log of actual movements.

Movement

During movement, everyone is responsible for land navigation. The commander emphasizes it at the OPORD, and each subordinate leader echoes this philosophy during his OPORD. Although the soldiers do not have maps and compasses, leaders need to disseminate the route plan to them and keep them informed of the unit's location throughout the movement. Armed with such information, each



soldier will be better prepared to carry on with the mission if he should be separated from the main body or if his leaders should become casualties.

During movement, the commander focuses his attention on the tactical situation and the mission instead of keeping his eyes on map and compass. His immediate thoughts should be on the unit's tactical disposition (use of cover and concealment, movement technique), reaction to enemy contact, and time schedule. As with the captain of a ship, he checks the unit's location through his tasked navigator, stops the unit whenever it loses its track or has navigation feedback conflicts, and takes action (map check, scouting party) to get the unit back on track. Good land navigation rests primarily on a good navigation plan.

Pace Count. Pace count is best calculated over a long course with varying terrain. Once a soldier has determined his pace, he should memorize it or write it on a laminated card and place it in his cap or helmet. In elevated and rough terrain, a normal pace count becomes inaccurate and requires a modified count. Repeated training and experience are the best ways to determine an accurate pace count in all types of terrain. Each soldier should note how the various terrain, weather, and light conditions affect his pace count and record it on his pace-count card. As with time expenditure calculations, making a record of modified pace counts helps the unit move with more confidence. Leaders must identify those soldiers who have a knack for accurate pace counts and use their talent.

During movement, the lead platoon reports the start and end point of each leg, referring to GPS if it is available. Each leader verifies the navigational assessment and concurs or offers recommendations. The commander makes the final decision regarding navigational questions as the time and the tactical situation require. To provide backup for the navigator, the lead platoon leader focuses on reading the route. He is located next to his main compass man and pace man for continuous consultation. He keeps his thumb on the route marked on the map to help him track

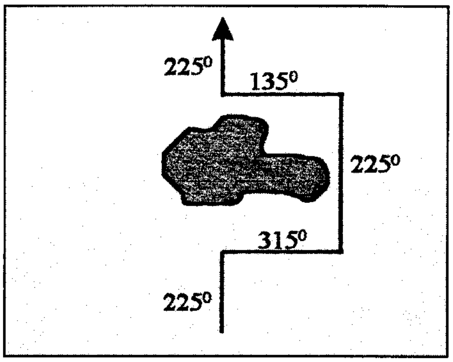


Figure 6. Box Method

rapidly. The compassman focuses up ahead on landmarks (or steering marks) to keep the unit moving on the right azimuth. The platoon leader reads the map on the move, checking it frequently to maintain terrain association. At night, this means he must use his red-filtered flashlight frequently, even if using it violates light discipline. If he keeps the flashlight close to the map, the amount of light escaping is very small (penlights are the most effective). The platoon leader focuses on remembering as many of the map details as possible and on reading the terrain ahead looking for features that will verify the unit's location. He also maintains a broad field of vision, constantly looking to the sides and rear to gain an appreciation of the terrain around him. He uses GPS only as the final verification of his location. Since land navigation skills are perishable, the unit must not rely solely on one piece of equipment for navigation; when it is not functioning or when the stock of batteries is depleted, the unit must still be able to continue the mission. When serving in this capacity, the lead platoon leader is not paying much attention to the tactical side of the operation. The platoon sergeant assumes this role and advises him when the tactical situation does not merit moving through certain terrain. At this point, the platoon leader must recommend an alternate route to the commander.

When obstacles block the route, the lead platoon leader reports the type of obstacle (swamp, water, clear-cut) to the commander and bypasses it. The accepted way to do this is to use the box method: Take the azimuth and add or subtract 90 degrees and move on this new azimuth until the obstacle is no longer in the path; move another distance along the original azimuth; then subtract or add 90 degrees to get back on the original course (Figure 6). For minor obstacles, the unit can use the zigzag method: Add or subtract 60 degrees, move a certain distance, then subtract or add 60 degrees, and move the same distance to get back on the original route (forming equilateral triangles along the route). This technique is also useful when negotiating steep slopes.

The company always navigates to an attack point within one kilometer of the ORP. The attack point is located on or near an easily recognizable and unique terrain feature. The company can use this as a linkup point with its scouts, who can occupy and mark it to ease the linkup. Even if it is not used for a linkup, it makes an excellent point from which a quartering party can easily locate and prepare the ORP for occupation. In this manner, the unit can smoothly occupy the ORP.

Getting back on course. Despite all this planning, the unit may get off its planned route as a result of enemy contact, bypassing an obstacle, unrecognizable terrain features, or navigational errors—assuming that GPS is not available. The worst course of action is to continue wandering around hoping to stumble on a recognizable terrain feature. The commander halts the company and calls his platoon and section leaders and their navigators to the command post for consultation. Together, they attempt to pinpoint their position, referring to the last identified terrain feature the unit passed. If light conditions are favorable and some clearly identifiable terrain features are in view, the leaders can use the intersection or resection method to determine the unit's location. After discussing the points at which the unit may have strayed, the commander dispatches patrols to verify the unit location. The commander informs the patrols of the unit's possible location and what terrain features—or, depending on the detail of the map, benchmarks, religious shrines, or natural features—to look for. He always has one patrol retrace the unit's steps to the last verified position in an attempt to see where the company got off track. Finally, he gives all patrols a return time (15 to 30 minutes) to keep them from trekking about for hours.

If unsuccessful, the commander can request an artillery or mortar spotting or illumination round on or over a checkpoint, target reference point, or the objective. If all else fails, a more dangerous method is to have higher headquarters contact an electronic warfare unit to triangulate the company position from its radio transmissions.

Using natural lines of drift. Lines of drift are ridgelines, spurs, streams, and valleys—anything that makes movement easier. The enemy recognizes these natural features too and is likely to focus his reconnaissance effort along them, particularly around the objective area. If following a ridge, the actual route should be between the crest and the valley floor. Animal trails are fast tracks and generally too numerous for the enemy to cover. The enemy's assets are limited, particularly on the defense, so he is forced to focus his efforts on choke points and lines of drift. If the company is forced to use an avenue along a line of drift, the commander should determine how far to use it, dispatch an advance guard far enough ahead to prevent the main body from becoming engaged if the advance card makes contact.

Although the number of steps and calculations may seem daunting, land navigation is not as difficult as the planner might imagine, once he has performed the procedure a couple of times. Delegating land navigation planning to a capable, experienced subordinate ensures that this crucial aspect of the operation receives the attention it deserves, even when time is short. Now the commander can give full attention to the tactical plan. Preparing a land navigation plan gives subordinates a better appreciation of the influence of climatic conditions, vegetation, terrain, and the soldier's load on time and space. This knowledge will reduce the delay associated with movements and will also serve the leaders well when they do their staff time later in their careers. Finally, the commander can focus his attention on the tactical situation during movement, knowing that subordinate leaders are tracking land navigation properly. This approach to an age-old problem not only adds predictability to mission planning, but also instills confidence and pride in every soldier and enables the unit to get to its objective with minimal delay and with its combat power intact.

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